SUPPORT DOCUMENT FOR BART DETERMINATION FOR

TRANSALTA CENTRALIA GENERATION, LLC POWER PLANT CENTRALIA, WASHINGTON

by
WASHINGTON STATE DEPARTMENT OF ECOLOGY
AIR QUALITY PROGRAM
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Table of Contents

Executive Summary

The Best Available Retrofit Technology (BART) program is part of the larger effort under the federal Clean Air Act Amendments of 1977 to eliminate human-caused visibility impairment in all mandatory federal Class I areas. Sources that are required to comply with the BART requirements are those sources that:

1. Fall within 26 specified industrial source categories;
2. Commenced operation or completed permitting between August 7, 1962 and August 7, 1977;
3. Have the potential to emit more than 250 tons per year of one or more visibility impairing compounds;
4. Cause or contribute to visibility impairment within at least one mandatory federal Class I area.

TransAlta Centralia Generation LLC Power Plant (TransAlta) operates a two unit, pulverized coal fired plant near Centralia Washington. Each unit of the plant is rated at 702.5 MW net output. Operation of a coal fired power plant results in the emissions of particulate matter (PM), sulfur dioxide (SO_2) and nitrogen oxides (NOx). All of these pollutants are visibility impairing.

Pulverized coal plants such as the TransAlta facility are one of the 26 listed source categories. The units at the plant began commercial operation in 1971 and 1972. The units have the potential to emit more than 250 tons per year of SO_2, NOx, and PM. As part of an approval of the Washington State Visibility SIP in 2002, EPA Region 10 determined that particulate and SO_2 controls installed as part of a 1997 Reasonably Available Control Technology (RACT) determination[1] issued by the Southwest Clean Air Agency (SWCAA)[2] met the requirements for BART and constituted BART for those pollutants. EPA specifically did not adopt the NOx controls in the RACT order as BART.

Modeling of visibility impairment was done following the Oregon/Idaho/Washington/EPA-Region 10 BART modeling protocol.[3] Modeled visibility impacts of baseline emissions show impacts on the 8th highest day in any year (the 98th percentile value) of greater than 0.5 deciviews (dv) at the twelve Class 1 areas within 300 km of the plant. The highest impact was 5.55 dv at Mt. Rainier National Park. Modeling showed that NOx and SO_2 emissions from the power plant are responsible for the facility's visibility impact.

TransAlta prepared a BART technical analysis following Washington State's BART Guidance.[4]

The Department of Ecology (Ecology) determined that BART for NOx emissions is the current combustion controls combined with the completion of the Flex Fuels project and the use of a sub-bituminous coal from the Powder River Basin or other coal that will achieve similar

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[1] SWAPCA Order No. 97-2057
[2] Previously known as the Southwest Air Pollution Control Authority (SWAPCA)
[3] Modeling protocol available at http://www.deq.state.or.us/aq/haze/docs/bartprotocol.pdf
[4] "Best Available Retrofit Technology Determinations Under the Federal Regional Haze Rule," Washington State Department of Ecology, June 12, 2007

emission rates. This change results in a 20% reduction of NOx emissions from the baseline period emission rate. The use of low sulfur PRB coal also reduces SO_2 emission by about 60% from the same period. The NOx reduction from the BART controls selected by Ecology will result in a visibility improvement from the baseline impacts at Mt. Rainier National Park of approximately 0.6 dv, with improvements of 0.2 to 0.6 dv at other affected Class I areas. The controls are to be installed and start continuously meeting the emission limitation by October 1, 2009.

1. INTRODUCTION

This document is to support Ecology's determination of the Best Available Retrofit Technology (BART) for the TransAlta Centralia Generation LLC (TransAlta) coal fired power plant located near Centralia, Washington.

The TransAlta plant is a coal fired power plant rated to produce a net of 702.5 MW per unit. The plant has 2 tangentially fired pulverized coal units currently using PR B sub-bituminous coal for fuel.

In a letter dated October 16, 1995, the National Park Service notified Ecology certified that there was uniform visibility haze visibility impairment at Mt. Rainier National Park. The Park Service expressed their belief that some or all of the haze was attributable to emissions from the Centralia coal fired power plant.

In 1997, the SWCAA issued a Reasonably Available Control Technology (RACT), Order No. 97-2057, for compliance with the requirements of Chapter 70.94.153 Revised Code of Washington. This order established emission reductions for SO_2 and NOx emissions from the coal fired boilers at the plant. The emission limitations in the Order were the results of a negotiation process involving SWCAA, the plant's ownership group, the National Park Service, US Forest Service, Ecology and the Environmental Protection Agency, Region 10 (EPA Region 10).

On June 11, 2003, EPA Region 10 approved the Ecology Visibility SIP submitted on November 9, 1999[5]. Ecology included the RACT emission reductions for Centralia as evidence of further progress in meeting the national visibility goals, but not as BART since no determination of attribution had been made as was required by the visibility rules in place in 1997. The Federal Register notice approving this 1999 submittal notes that while the National Park Service had certified visibility impairment at Mt Rainier National Park "The State of Washington has not determined that this visibility impairment is reasonably attributable to the CPP [Centralia Power Plant]."

The EPA approval of Ecology's 1999 visibility SIP submittal included a determination by EPA that the SO_2 and PM limits and controls required by the 1997 RACT order issued by SWCAA met the requirements of BART. EPA's determination that SO_2 and PM emissions were BART level of control were based on an analysis performed by Region 10 staff and an example analysis in the Technical Support Document issued by SWCAA.

In the Federal Register notice, the EPA specifically did not include the NOx emission limit in the RACT Order as BART stating "while the NOx emission limitation may have represented BART when the emission limits in the RACT Order were negotiated, recent technology advancements

[5] 68 *Federal Register* 34821, June 11, 2003.

have been made. EPA cannot say that the emission limitations in the SWAPCA[6] RACT Order for NOx represent BART."

As a result of the June 11, 2003 approval of the Washington State Visibility SIP, the TransAlta plant is subject to BART under the Regional Haze program only for its NOx emissions[7].

1.1. The BART Analysis Process

TransAlta and Ecology used EPA's BART guidance contained in Appendix Y to 40 CFR Part 51, as annotated by Ecology, to determine BART. The BART determination for coal fired power plants greater than 750 MW of total output must follow the process in BART guidance. The BART analysis protocol reflects utilization of a five-step analysis to determine BART. The 5 steps are:

1. Identify all available retrofit control technologies;
2. Eliminate technically infeasible control technologies;
3. Evaluate the control effectiveness of remaining control technologies;
4. Evaluate impacts and document the results;
5. Evaluate visibility impacts.

The BART guidance limits the types of control technologies that need to be evaluated in the BART process to available control technologies. Available control technologies are those which have been applied in practice in the industry. The state can consider additional control techniques beyond those that are "available," but is not required to do so. This limitation to available control technologies contrasts to the Best Available Control Technology (BACT) process where innovative technologies and techniques that have been applied to similar flue gasses must be considered.

In accordance with the EPA BART guidance, Ecology weighs all 5 factors in its BART determinations. To be selected as BART, a control has to be available, technically feasible, cost effective, provide a visibility benefit, and have minimal potential for adverse non-air quality impacts. Normally the potential visibility improvement from a particular control technology is only one of the factors weighed for determining whether a control constitutes BART. However, if two available and feasible controls are essentially equivalent in cost effectiveness and non-air quality impacts, visibility improvement becomes the deciding factor in the determination of BART.

1.2. Basic Description of the TransAlta Centralia Power Plant

The TransAlta plant is a 2 unit, pulverized coal boiler based power plant that currently uses Powder River Basin (PRB) coal. The boilers were initially commissioned in 1971 and 1972.

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[6] At the time, SWCAA was known as the Southwest Air Pollution Control Agency (SWAPCA).
[7] Letter from Mahbubul Islam, EPA Region 10, to Robert Elliott, SWCAA, and Phyllis Baas, Ecology, on Best Available Retrofit Technology Applicability for the TransAlta Centralia Power Plant (September 18, 2007).

Each unit is currently rated at 702.5 MW (net) output capacity. The units are identical tangentially fired, wet bottom units designed by Combustion Engineering.

TransAlta also operates 2 other generating resources that are part of the Centralia power plant complex. Operating under the name of Centralia Gas is a group of 4 combined cycle combustion turbines producing 248 MW. The combustion turbines were built in 2002 and were subject to PSD permitting requirements. They are currently operated as peaking units. The combined cycle turbines are electrically and physically separate from the coal units. There is also a 1 MW hydropower facility located at TransAlta's Skookumchuck River Dam and Reservoir.

In addition to the above electricity generating units, the plant includes numerous other units, including an oil fired auxiliary boiler used for cold starting of the coal fired boilers. This unit is severely limited in its allowed annual operations.

SO_2 control on the 2 coal fired boilers is provided by a wet limestone, forced oxidation wet scrubber system. This system removes over 95% of SO_2 in the flue gas from the boilers. The SO_2 controls were installed in the 1999 – 2002 time period.

Particulate control is provided by 2 electrostatic precipitators in series followed by the wet scrubber system. The first electrostatic precipitators were part of the original construction of the plant. The second precipitators date from the late 1970's.

Current NOx control is provided by combustion modifications incorporating low NOx burners with close-coupled and separated over-fire air[8]. These combustion modifications are collectively known as "LNC3." The controls were installed in the 2000 – 2002 time period in response to the RACT Order. The combustion controls were designed and optimized to suit Centralia mine coal.

For a variety of reasons, TransAlta stopped active mining at the Centralia coal mine and now purchases all coal from PRB coal fields. To accommodate the change, the company has modified the rail car unloading system to handle up to 10 coal unit trains per week. Additional modifications are focused on the boilers. The boilers have been and will be modified to reduce temperatures in the flue gas to accommodate the higher Btu coal now being combusted. Additional changes include the reinstallation of specific soot blowers and installation of new soot blowing equipment (steam lances) necessary to accommodate the different ash characteristics of the PRB coals. Improved fire suppression equipment is being installed to accommodate the increased potential of PRB coals to catch fire spontaneously.

TransAlta anticipates operating the plant until at least 2030. They acknowledge that to operate beyond 2025 will require significant plant upgrades to assure safe and reliable operation into the future.

The power plant is subject to the federal Clean Air Act's Title V permitting program. The plant operations are covered by air operating Permit No. SW98-8-R2-B, issued March 25, 2008 by

[8] This set of combustion controls are the basis of the presumptive BART limits of 0.15 lb NOx/MMBtu in Section 4.E of EPA's BART Guideline

SWCAA. Ecology received a BART analysis from TransAlta in February, 2008, which was revised and resubmitted in July 2008 and supplemented in December 2008.

1.3. BART Eligible Units and Pollutant at TransAlta Centralia Power Plant

The TransAlta facility located near Centralia Washington includes a number of different operations and units. Emissions from the plant are primarily generated and emitted by the 2 coal fired boilers of the main power plant. The oil fired auxiliary boiler is operated infrequently and is permitted to use a limited number of gallons of fuel oil each year. The auxiliary boiler is used during cold start-up of the coal boilers to heat the boiler water to prevent thermal shock and failure of cold boiler tubes. Emissions from the auxiliary boiler were not evaluated for BART.

As noted above, NOx is the only pollutant addressed in this BART analysis. As required by the BART guidance and modeling protocol, the maximum day emission rate in the calendar 2003 to 2005 period was determined. The hourly NOx emissions on the day with maximum emissions during the baseline period (2003-2005) were 2,474 lb/hr (0.302 lb/MMBtu) for Unit 1 and 2,510 lb/hr (0.306 lb/MMBtu) for Unit 2.

1.4. Visibility Impact of BART Eligible Units at TransAlta Centralia Power Plant

Class I area visibility impairment and improvement modeling was performed by TransAlta using the BART modeling protocol developed by Oregon, Idaho, Washington, and EPA Region 10[9]. This protocol uses 3 years of metrological information to evaluate visibility impacts. As directed in the protocol, TransAlta used the highest 24 hour emission rates for NOx, SO_2, and PM/PM_{10} that occurred in the 3 year period to model its impacts on Class I areas. The modeled SO_2 and PM/PM_{10} emission rates complied with their respective emission limits. The modeling indicates that the emissions from this plant cause visibility impairment on the 8th highest day in any one year and the 22nd highest day as all mandatory federal Class I areas within 300 km of the power plant [10]. For more information on visibility impacts of this facility, see Section 3 below.

1.5. Relationship of this BART Analysis to the 1997 RACT Analysis and Determination

As noted previously, in 1997 the SWCAA finalized a determination of Reasonably Available Control Technology (RACT) for the Centralia Power Plant. As part of the technical analysis that led to the determination of RACT for NOx emissions from this plant, 37 different emission control alternatives were evaluated (see appendix B for the list). The analysis documents produced by the plant's owners reviewed many alternative techniques potentially applicable to the facility. The list of controls reviewed ranged from proven methods of combustion control to methods that had only been proven to work in the laboratory. The alternate technologies evaluated at that time included methods such as natural gas reburn, Selective Non-Catalytic Reduction, Selective Catalytic Reduction, and several options which could control NOx and SO_2 with the same control system.

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[9] A copy of the modeling protocol is available at http://www.deq.state.or.us/aq/haze/docs/bartprotocol.pdf
[10] A source causes visibility impairment if its modeled visibility impact is above 1 dv, and contributes to visibility impairment if its modeled visibility impact is above 0.5 dv.

As discussed in the company's analysis and the SWCAA support document, these technologies were not selected as RACT for NOx emissions in favor of the installation of the package of combustion modifications that are now recognized as LNC3.

Since the 1997 RACT Determination, Ecology has tracked development and installations of NOx control technologies. Based on the large list of emission controls that had been reviewed to support the RACT determination, the relatively slow development of some techniques, and disappearance of some other techniques, Ecology allowed TransAlta to use the evaluation from the 1997 RACT determination to narrow the list of potential control technologies appropriate for this BART review.

The BART analysis by TransAlta focused on those controls that are available and have been implemented on coal fired boilers of the general size of the plant. For more details on the control options evaluated for the RACT analysis, please refer to the RACT report by PacifiCorp for the Centralia Power Plant and the SWCAA Technical Support Document supporting the RACT determination.

2. SUMMARY OF TRANSALTA CENTRALIA POWER PLANT'S BART TECHNOLOGY ANALYSIS

The TransAlta's BART technology analysis was based on the five step process defined in BART guidance and listed in Section 1.1 of this report. This section is an overview of TransAlta's BART analysis and supplemental material provided by the plant's owner.

2.1. NOx Controls Evaluated

The plant already has installed combustion controls to reduce NOx emissions from thermal NOx. The controls currently installed are considered the base case from which the effects of other controls are evaluated.

Table 2-1 NOx Controls Evaluated

Control technology	Control Efficiency	Technically feasible?
Low NOx burners with close coupled and separated overfire air (LNC3)	--	Yes, already installed
Flex Fuel Project – Existing LNC3 combustion controls plus change in fuel to PRB coal and boiler modifications to accommodate use of PRB type coals		Yes, LNC3 already installed, Unit 2 Flex Fuel modifications completed in 2008, Unit 1 to be completed Summer 2009
SCR	Up to 95% reduction	Yes
SNCR	20 - 40% reduction	Yes
ROFA/RotaMix	Unknown	No
Neural net controls	Up to 15%	Yes

LNC3
As noted above, the **combustion controls** known as LNC3 are currently installed on each of the boilers at the plant. These controls have demonstrated an ability to meet the current NOx emission limit of 0.30 lb. NOx/MMBtu using Centralia mine coal and PRB coals.

The Centralia Plant's implementation of the LNC3 technology was included in EPA's control effectiveness evaluations leading to its determination of the presumptive BART limits of 0.15 lb NOx/MMBtu in Section 4.E of EPA's BART Guideline. In 2004 in connection with its adoption of the final BART Guidelines, EPA found that of the 17 boilers in the U.S. with the boiler design of the Centralia Plant's (tangential-fired) that burn sub-bituminous coal, two of the units with LNC3 installed prior to 1997 did not meet the presumptive BART limit. Seven of the units with pre-1997 design did meet the presumptive limit. Of the remaining eight units with LNC3 technology installed in 1997 or after, the two Centralia boilers were the only two that did not meet the presumptive limit. (EPA-HQ-OAQ-2002-076-0446(1) TSD). It is unknown why the LNC3 technology installed at the Centralia Plant fails to meet the presumptive BART limit.

Flex Fuel project

TransAlta has proposed its Flex Fuel project as an addition to the currently installed LNC3 combustion controls for consideration as BART emission control. The Flex Fuel project is a series of actions being undertaken by the company to accommodate the exclusive use of sub-bituminous coals with ash, nitrogen and sulfur contents similar to PRB sub-bituminous coals. Combustion modeling of the boilers performed by Black & Veatch using EPRI's Vista model using a representative PRB coal has indicated that the proposed changes will result in a reduction of the hourly and annual emission rate for NOx.

TransAlta decided to rely on PRB coal after suspending mining operations for Centralia sub-bituminous coal at the end of 2006. PRB coals have a number of characteristics that differ significantly from the Centralia coal the plant was designed to use. Important characteristics that affect the boilers' operation are the net heat content, the quantity of ash, and the abundance of sodium. Appendix A contains tables showing the important characteristics of typical PRB coals and the Centralia coal.

The most important differences between the coals is the heat content (Btu/lb), lower fuel nitrogen, lower sulfur content, the moisture content, and the concentration of sodium. Centralia coal is very low in sodium, higher in fuel nitrogen and sulfur content, and much higher in water content than the PRB coals. The difference in sodium content changes the ash that deposits on the boiler tubes from light and fluffy (Centralia) to glassy and sticky (PRB).

The boiler tube slagging and fouling characteristics of PRB coal increase the heat rates of the boilers compared with Centralia Mine coal. The Flex Fuel Project incorporates physical changes to the pressure parts in each boiler's convective pass that improve heat transfer by reducing the boiler's susceptibility to ash deposition. The major individual pressure part changes include: (a) reheater replacement to maximize soot blower cleaning effectiveness on the tube assembly surface areas, and (b) additional low temperature superheater and economizer heat transfer surface area to result in higher boiler efficiency and a lower flue gas exit temperature. Other significant changes associated with this project are reinstallation of some of the original soot blowers and installation of new 'soot blowing' equipment specifically designed to remove the now sticky and glassy soot from the boiler tubes. These changes allow for more efficient heat transfer within the boiler. Additional discussion of this project's effects and the combustion thermodynamic modeling performed to estimate the emissions decrease from the project can be found in the *BART Analysis Supplement* by TransAlta dated December 2008 and the *TransAlta Centralia Boiler Emissions Modeling Study* by Black & Veatch, dated Sept. 2007.

No changes to the fuel delivery equipment (other than adding fire suppression equipment), burners, combustion air system, or steam turbine are being made. The Flex Fuel Project allows the boilers to burn PRB coal more efficiently, but does not increase the boilers' potential steam generating capacity.

The lower nitrogen content of the PRB coals combined with the lower total quantity of fuel required to produce the same heat input rate to the boilers, along with the potential for additional steam production after the project has been completed on both units, will reduce the emissions of NOx by approximately 20% from the rates during the 2003 – 2005 period. The emission rates during that baseline period averaged 0.304 lb NOx/MMBtu and at the completion of the Flex Fuel project are expected to be below 0.24 lb/MMBtu.

Annual average NOx emissions from December 1, 2003 through November 31, 2005 were 15,695 tons. Based on the proposed BART rate of 0.24 lb/MMBtu, the BART limit would reduce emissions by 3,139 tons/year to 12,556 tons/year.

The estimated capital to implement Flex Fuels on both units is $101,808,663, based on the actual costs to implement the Flex Fuels project on Unit 2 and the expected costs of installation on Unit 1. The annualized cost of the Flex Fuel Project is $11,184,197. Based on the estimated NOx reductions of 3,139 tons/yr, the cost-effectiveness of the Flex Fuel Project is $3,563/ton of NOx reduced. Since the Flex Fuel Project also reduces SO_2 emissions by an estimated 1,287 tons/year, TransAlta has calculated that the overall cost-effectiveness of the Flex Fuel Project as $2,526/ton of NOx plus SO_2 reduced[11].

Neural net controls
Neural net controls for boilers are a relatively new technique. It is based on using a number of different boiler operational information and using that information to continuously optimize the combustion efficiency of the boiler. While numerous venders will provide this technology, TransAlta received detailed information from NeuCo, Inc. (NeuCo). NeuCo offers several neural net optimization products. Two of their products, CombustionOpt and SootOpt, provide the potential for NOx reduction at some facilities. Both CombustionOpt and SootOpt are control-system-based products. CombustionOpt provides for optimized control of fuel and air to reduce NOx and improve fuel efficiency. SootOpt improves boiler soot blowing by proportioning heat transfer and reducing "hot spots" resulting from ineffective cleaning. NeuCo stated that these products can be used on most boiler control systems and can be effective even in conjunction with other NOx reduction technologies.

NeuCo predicts that generally CombustionOpt can reduce NOx by 15 percent, and SootOpt can provide an additional 5 to 10 percent. Expected NOx reductions are very unit-specific, and actual results may vary greatly. Previously received budgetary prices for CombustionOpt and SootOpt were $150,000 and $175,000, respectively, with an additional $200,000 cost for a process link to the unit control system.

Because NeuCo does not guarantee NOx reduction, the estimated emission reduction levels provided are not considered as reliable projections. In light of the uncertain and unquantifiable emission reductions, TransAlta considers a neural net system as a potential supplementary or polishing technology, but not as an applicable NOx technology for this BART analysis. Because of the potential NOx reductions and cost effectiveness, TransAlta is continuing to investigate use of this technique at this plant.

Selective non-catalytic reduction (SNCR)

[11] Because the Flex Fuel Project is not being implemented for the primary purpose of emissions reduction, these cost effectiveness values are not directly comparable to those for installation of a control technology.

SNCR is generally used to achieve modest NOx reductions. It is often chosen to augment combustion controls on older coal fired boiler units which are generally smaller units (units with heat input less than 3,000 MMBtu/hr) and industrial boilers. With SNCR, an ammonia or urea solution is injected into a location in the furnace that provides a temperature range of 1,600 degrees Fahrenheit (°F) to 2,100°F and provides a minimum detention time for the reaction to occur. Within this temperature range the ammonia or urea reduces NOx to nitrogen and water. NOx reductions of up to 60 percent have been achieved, although 20 to 40 percent is more realistic for most applications.

Reagent utilization, which is a measure of the efficiency with which the reagent reduces NOx, can range from 20 to 60 percent, depending on the amount of reduction to be achieved, unit size, operating conditions, and allowable ammonia slip. If the temperature in the boiler at the location of the ammonia injection is too high or too much ammonia is injected, the ammonia or urea is oxidized to NOx. With low reagent utilization, low temperatures, or inadequate mixing, ammonia slip occurs, allowing unreacted ammonia to create problems downstream.

There are a number of potential adverse impacts due to ammonia slip. Unreacted ammonia can contaminate the fly ash collected in the ESPs that is sold for making concrete. If the ammonia concentration in the fly ash is high enough it will render the fly ash odorous and unsaleable[12]. If the fly ash is unsaleable to make concrete, it would require disposal in a landfill or could be sold to a cement plant as a raw material to make cement. If used to make cement, the heating of the fly ash in a cement kiln will release any mercury that may be contained in the fly ash.

Two additional issues with ammonia slip are that ammonia is listed as a toxic air pollutant by Ecology, and its discharge from the stack may result in additional impacts. The unreacted ammonia may also react with sulfur oxides to generate ammonium sulfate or bisulfate to foul economizer, air preheater, and other duct surfaces. At facilities where there is no wet scrubber system included, excess ammonia may also create a visible stack plume. Since the TransAlta plant has a wet scrubber, no additional plume visibility would be anticipated.

The control effectiveness of SNCR is a function of many variables, including the uncontrolled emissions concentrations, physical conditions, and operational conditions. A study by Harmon[13] (1998) indicates that a large coal fired, tangentially fired unit equipped with a low NOx SNCR has the potential to reduce NOx emissions by only 20 to 25 percent with an ammonia slip of less than 10 ppm. The EPA Office of Air Quality Planning and Standards' *EPA Air Pollution Control Cost Manual* (EPA, 2002) states "SNCR systems applied to large combustion units (greater than 3,000 MMBtu/hr) typically have lower NOx reduction efficiencies (less than 40 percent), due to mixing limitations." The Centralia Power Plant units have heat input rates of

[12] Fly ash is reported to lose its desirability as a concrete admixture if the ammonia content is high enough that detectable levels of ammonia will be volatilized from the fly ash when it is mixed into the wet concrete. Ammonium on /in the fly ash is converted to ammonia when the pH of the mixture rises. At a pH of 12, essentially all the ammonium is converted to ammonia in solution. Based on the literature, it is unlikely that a properly controlled SNCR system will cause any adverse impacts to fly ash sales due to ammonia slip.

[13] Harmon, A., et al. 1998. Evaluation of SNCR Performance on Large-Scale Coal-Fired Boilers. Institute of Clean Air Companies (ICAC) Forum on Cutting NOx Emissions, Durham, NC, March 1998

much greater than 3,000 MMBtu/hr (above 7,000 MMBtu/hr[14]). After considering the above factors and a reasonable compliance factor, TransAlta selected a control effectiveness of 25 percent for this evaluation.

TransAlta's cost analysis uses a urea-based SNCR system providing a nominal 25 percent reduction in NOx levels with a 5 ppm ammonia slip. A 5 ppm ammonia slip is the maximum recommended taking into account the flue gas sulfur levels to avoid problems with ammonium sulfate and bisulfate fouling of the air heater. To achieve the proposed reduction, multiple nozzle lances are proposed to handle load changes from 50 to 100 percent.

Retrofit costs to incorporate SNCR at this facility are included in the cost estimate. These retrofit costs are higher than for other similarly sized facilities due to an extremely tight boiler outlet configuration, limited available space for new equipment, probable modifications to boiler tubes to accommodate the urea injection lances, construction access difficulties to install SNCR injection equipment, and location of urea storage and solution preparation equipment.

TransAlta has estimated that installation of SNCR on their units would consume about 700 kW-h of electricity per unit, or a total of 1.4 MW-h for both units.

The anticipated 25% reduction in emissions from the installation of SNCR would result in an emissions limitation of 0.225 lb/MMBtu and an emission reduction of 3,923 tons/year. TransAlta has estimated that the estimates of capital cost including the retrofit costs, adding SNCR to both units at the plant would cost $33.2 million with a cost effectiveness of $2,258/ton NOx reduced.

Selective Catalytic Reduction (SCR)
SCR works on the same chemical principle as SNCR, but SCR uses a catalyst to promote the chemical reaction. Ammonia or urea is injected into the flue-gas stream, where it reduces NOx to nitrogen and water. Unlike the high temperatures required for SNCR, the SCR reaction takes place on the surface of a vanadium/titanium-based catalyst at a temperature range between 580°F and 850°F. Due to the catalyst, the SCR process is more efficient than SNCR resulting in lower NOx and ammonia emissions. Typically an SCR system can provide between 70 and 95% reduction in NOx emissions.

On coal fired power plants, the most common type of SCR installation is known as the hot-side high-dust configuration, where the catalyst is located downstream from the boiler economizer and upstream of the air heater and particulate control equipment. In this location, the SCR is exposed to the full concentration of fly ash in the flue gas that is leaving the boiler. An alternate location for an SCR system is downstream of the air heater or the particulate control device. In many cases, this location is compatible with use of a low temperature SCR catalyst or is within the low end of the temperature range of a conventional catalyst. Because the temperature of the flue gas leaving the air heaters and the Electrostatic Precipitators (ESPs) is too cool for the low temperature versions of SCR catalyst to operate, the high-dust configuration is assumed for TransAlta.

[14] 2008 Acid Rain Program report lists heat input rate at 8500 MMBtu/hr/boiler

In a new boiler installation or a retrofit installation where the existing boiler has minimal emission controls installed, the flue gases are routed through the catalyst in a downward direction aiding in dust removal. In a retrofit situation, the SCR catalyst is normally located in the existing gas duct, which may be expanded in the area of the catalyst to reduce flue gas flow velocity and increase flue gas residence time.

A new installation type SCR was used as the basis for analysis at the Centralia Plant because of the lack of room to install an SCR catalyst in the existing flue duct and the higher removal rate provided by a new, full size catalyst bed. The short distance between the boiler economizer and the entrance to the first ESP does not provide the room required for a catalyst bed with reasonable velocities to be inserted in the existing flue gas duct[15]. The ducts from each boiler to the ESP have a relatively high velocity, such that the amount of catalyst that could fit into the unmodified duct would have minimal effectiveness due to the short residence time through the catalyst bed.

As a result of electing to use a full scale, new installation type design, an adjustment was used for SCR cost estimates due to the Centralia Plant's extremely tight boiler outlet ductwork configuration as shown in Figures 3-3, 3-4, and 3-5 of the June, 2008 Revised BART analysis and limited available space for new equipment. As can be seen in the figures, installation of a full-scale SCR system requires reconfiguration of the flue ducts from the boilers, structural modifications of the ESP to accommodate the weight of the SCR catalyst and duct work, and realignment of the duct work from the SCR units to the ESP inlets. The restricted site layout, support structure needs, intricate duct routing, limited construction space, and complexity of erection increases the capital cost.

Each boiler at the Centralia Plant has two exhaust gas ducts to aid in splitting the flow to the ESPs. As a result each boiler would require two smaller, separate catalyst vessels instead of a single large catalyst vessel. The capital cost of installing dual catalyst vessels for each unit is slightly greater than a single catalyst vessel for units of similar size.

As in the case for SNCR, a potential adverse impact due to unreacted ammonia from the SCR system is that it may render fly ash unsaleable. At facilities where there is no wet scrubber system included, excess ammonia could also create a visible stack plume. Again, TransAlta has a wet scrubber, so a visible stack plume from ammonia is not likely.

As stated in TransAlta's BART analysis, an SCR retrofit increases the electricity consumed by the existing flue gas fan system to overcome the additional pressure drop associated with the new catalyst, typically a 6- to 8-inch water gage increase. The increase in pressure drop results in marginally higher operating costs and additional capital cost. Since the BART analysis uses a planning level cost analysis, there has not been a more detailed engineering study of all components that may be affected by adding the SCR system.

[15] See Figures ES-1, 3.2, 3-4, and 3.5 of the BART Analysis for Centralia Power Plant, Revised July 2008.

TransAlta evaluated 2 options to use SCR at the plant. One option included SCR on only one unit to achieve the Presumptive BART emission limit of 0.15 lb NOx/ MMBtu, both units averaged together. The other option included SCR on both units.

The emissions reduction for installation of SCR (at a 95% removal rate) on one unit would be 7,450 tons/year. The capital cost for including SCR on only one unit was estimated to be $290.1 million with a cost effectiveness of $8,205/ton NOx reduced.

The emissions reduction for installation of SCR (at a 95% removal rate) on both units would be 14,910 tons/year. The capital cost for including SCR on both units would be double that for one unit with a cost effectiveness of $9,091/ton NOx reduced.

ROFA (rotating overfire air) and Rotamix

Mobotec markets ROFA (rotating overfire air) as an improved second-generation overfire air distribution system. In their system the combustion gases in the boiler are set in rotation with asymmetrically placed air nozzles. According to Mobotec installation information, the ROFA technology alone has not been installed on any tangentially-fired coal unit greater than 175 MW.

The Mobotec Rotamix technology is a modification of the SNCR process. The ammonia or urea solution is added using lances in conjunction with the ROFA air nozzles to improve both the chemical distribution and lengthen the residence time for the reactions to occur. According to the Mobotec installation list, the largest tangentially-fired coal unit using the Mobotec ROFA/Rotamix combination is 175 MW. The Rotamix SNCR system is anticipated to provide NOx reductions similar to conventional SNCR systems[16].

Based upon the BART guidance, Mobotec ROFA and Rotamix technologies are ‘available’ because they have been installed and operated successfully on tangentially fired pulverized coal boilers. TransAlta believes that while the ROFA and Rotamix technology are ‘available’ control technologies as described in the BART guideline, the use of either ROFA as a replacement or addition to the current overfire air injection system or installation of the Rotamix process are not technically feasible technologies due to unknown difficulties with installation on their boilers. Due to perceived risks of scale-up to their unit size, TransAlta believes that these technologies are not applicable to their facility.

2.2 TransAlta’s Proposed BART

The existing LNC3 combustion controls (low NOx burners, close coupled and separated overfire air) currently installed at the plant and the Flex Fuels project meeting an emission limitation of 0.24 lb NOx/MMBtu is proposed as BART for their facility.

[16] The Mobotec combustion air injection techniques were not evaluated as part of the RACT process. Their development occurred after the RACT determination had been made.

3. VISIBILITY IMPACTS AND DEGREE OF IMPROVEMENT

TransAlta modeled the visibility impairment for the baseline years per the modeling protocol and the potential improvement from the control scenarios that they evaluated as potential BART controls for their facility. In modeling the emissions, they followed the BART modeling guidance prepared for use by sources in Washington, Oregon, and Idaho. In accordance with the EPA BART guidance, this modeling protocol utilizes the CALPUFF modeling system and the 'old' IMPROVE equation to convert modeled concentrations to visual impairment. This approach is consistent with most of the states included in the Western Regional Air Partnership for modeling individual source visibility impairment. The 'old' IMPROVE equation is used because it is included within the CALPUFF modeling system and is part of the EPA accepted version of the model per 40 CFR Part 51, Appendix W. A new equation is available, but is not included within the version of the CALPUFF modeling system specified in the modeling protocol.

The results of the TransAlta modeling are shown in Table 3-1 for all Class I areas within 300 km of the plant plus the Columbia River Gorge National Scenic Area. Table 3-1 shows the maximum day impairment due to TransAlta, the highest of the 3, 98^{th} percentile days of each year modeled, and the 98^{th} percentile day of all 3 years modeled. Also shown is the modeled visibility impairment resulting from the control scenarios modeled by TransAlta. The modeled dv impacts for the baseline condition and the 3 control scenarios for the 98^{th} percentile day (22^{nd} day over the three year period) are included in Table 3-1[17].

The emission rates modeled were derived from operating records for each boiler and reflect the highest 24 hour emission rate within the 3 years that were modeled. The proposed emission rates were applied to this maximum 24 hour operating rate and those rates were then used for modeling the visibility impairment/improvement that could be achieved through the use of the proposed controls. The modeled emission rates are shown in Table 3-1.

The modeled visibility impairment indicates that the plant causes visibility impairment at all Class I areas within 300 km of the plant. The tables include modeled visibility levels for three alternative control scenarios, including the highest level of control considered by TransAlta to be available for the plant, SCR applied to both boilers.

Ecology modelers have reviewed the modeling performed by TransAlta and have found that the modeling complies with the Modeling Protocol and produces a reasonable result.

The modeled emission reductions from the 4 control options modeled by the company result in substantial reduction in the visibility impairment caused by the Centralia Plant in all Class I areas modeled and in the Columbia River Gorge NSA. For example, Table 3-1 shows that at the 3 most heavily impacted Class I areas, Olympic National Park, Mt. Rainier National Park, and the Goat Rocks Wilderness, TransAlta's proposed BART controls would provide 0.45 to 0.6 dv

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[17] See the BART Determination Modeling Analysis, TransAlta Centralia Generation Power Plant by Geomatrix Consultants, Inc, June 2008, for additional information on the modeling results for the other control scenarios evaluated. This report is part of the July 2008 BART analysis report.

reduction in visibility impairment in each of these areas. All Class I areas within 300 km of the plant are modeled to have visibility improvements of at least 0.2 dv from the NOx emission reduction from use of SNCR or Flex Fuels.

The modeling for the 3 control scenarios in the table only evaluates the NOx reduction impacts. Effects of SO_2 reductions which would occur as a result of implementing the Flex Fuels project were not evaluated by TransAlta. The actual SO_2 emission rates from usage of PRB coals are anticipated to result in an additional reduction of about 1,287 tons/yr from the baseline emission rates. This SO_2 reduction will provide additional visibility improvement over what has been modeled.

In their review of the modeling results, TransAlta's modeling consultant evaluated the modeling results to see if there were any patterns to the modeled impacts, such as season of the year, primary pollutant, or grouping of Class I area. Their review indicated that groups of Class I areas exhibited similar patterns. They found that the 12 Class I areas fell into 4 groups which coincide with both their physical locations and the modeled visibility effects. For their evaluation, see pages 8 and 9 of the June 2008 BART modeling report.

The important points to consider are that for the "East" group (Mt. Rainier N. P. and Goat Rocks and Mt. Adams Wildernesses) most impacts occurred in the summer due to SO_2 emissions. The expected high impacts due to NOx do not occur because the weather patterns transport the plant's plume to other areas in the winter seasons. The impacts on Olympic NP, (the sole member of the "Northwest" group) occur during wintertime stagnation episodes. While not mentioned in the report, this impact would be dominated by nitrates. For the "South" group (Mt. Hood, Mt. Jefferson, and Three Sisters Wildernesses) there are summertime impacts, but the highest potential visibility changes occur in the winter during wintertime stagnation episodes. Again, the wintertime events are dominated by nitrates. At the remaining 4 Class I areas (the "Northeast group"), there was no obvious seasonality or trends. The figures in Appendix D graphically depict this information for some of the Class I areas.

Overall, the visibility impacts from the plant's emissions on Class I areas are dominated by nitrates. The tables in Appendix D[18] depict the chemical species contributions to visibility impairment for the baseline case, the Scenario 2 Flex Fuels case and the Scenario 1 SNCR case as predicted by CALPUFF. Again, consistent though not identical with the evaluation by TransAlta's modeling consultant, at most nearby Class I areas, the visibility impairment on the 98th percentile worst days is primarily caused by the nitrate resulting from the plant's emissions. These worst days primarily occur in the September through June time period. Conversely, at the more distant Class I areas the visibility impairment is more variable, but the 98th percentile days usually occur in the June through September period and are dominated by sulfates. For more details, please refer to the Modeling Reports supplied by TransAlta.

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[18] From Geomatrix BART Modeling Reports, June 2008 and January 2008.

Table 3-1 3-Year Delta Deciview Ranking Summary

Class I Area	Visibility Criterion	Baseline Emissions	Control Scenario 1: SNCR	Control Scenario 2: Flex Fuel	Control Scenario 3: SCR on both units
Alpine Lakes Wilderness	Max 98% value (8th high)	4.871	4.393	4.469	3.057
	3-yrs Combined 98% value (22nd high)	4.346	3.844	3.918	2.531
Glacier Peak Wilderness	Max 98% value (8th high)	3.615	3.209	3.282	2.036
	3-yrs Combined 98% value (22nd high)	2.622	2.294	2.348	1.562
Goat Rocks Wilderness	Max 98% value (8th high)	4.993	4.398	4.538	3.137
	3-yrs Combined 98% value (22nd high)	4.286	3.708	3.802	2.385
Mt. Adams Wilderness	Max 98% value (8th high)	3.628	3.118	3.259	1.984
	3-yrs Combined 98% value (22nd high)	3.628	3.152	3.236	1.934
Mt. Hood Wilderness	Max 98% value (8th high)	3.471	3.051	3.119	2.082
	3-yrs Combined 98% value (22nd high)	2.830	2.388	2.457	1.543
Mt. Jefferson Wilderness	Max 98% value (8th high)	2.079	1.784	1.832	1.159
	3-yrs Combined 98% value (22nd high)	1.888	1.596	1.643	1.061
Mt. Rainier National Park	Max 98% value (8th high)	5.447	4.774	4.878	3.359
	3-yrs Combined 98% value (22nd high)	5.489	4.743	4.854	3.275
Mt. Washington Wilderness	Max 98% value (8th high)	2.027	1.756	1.799	1.170
	3-yrs Combined 98% value (22nd high)	1.414	1.248	1.275	0.855
North Cascades National Park	Max 98% value (8th high)	2.821	2.496	2.548	1.658
	3-yrs Combined 98% value (22nd high)	2.212	1.887	1.940	1.183
Olympic National Park	Max 98% value (8th high)	4.645	4.040	4.130	2.506
	3-yrs Combined 98% value (22nd high)	4.024	3.456	3.546	2.339
Pasayten Wilderness	Max 98% value (8th high)	1.954	1.701	1.737	1.160
	3-yrs Combined 98% value (22nd high)	1.482	1.318	1.353	0.864
Three Sisters Wilderness	Max 98% value (8th high)	2.172	1.910	1.956	1.172
	3-yrs Combined 98% value (22nd high)	1.538	1.328	1.361	0.902
Class II area modeled per the Modeling Protocol					
Columbia River Gorge National Scenic Area	Max 98% value (8th high)	2.545	2.193	2.250	1.347
	3-yrs Combined 98% value (22nd high)	2.353	1.942	2.008	1.182
Modeled Rates (lb/hr)	**Both units added together**				
	NOx -->	4,984	3,738	3936	1148
	SO_2 -->	4,522	4,522	4,522	4,522

The 8th day in any year or the 22nd day over the 3 year period, are the 98th percentile days.

4. ECOLOGY'S BART DETERMINATION

Ecology has reviewed the information submitted by TransAlta. The following discussions present our rationale for our determination.

4.1. NOx Control

The BART analysis reports and supplemental material provided by TransAlta indicate that the Flex Fuels project and SNCR are the only feasible controls for use at the Centralia power plant. We concur with their determination of feasible controls. This concurrence is based on our evaluations of their submittals plus Ecology research on potential controls.

4.1.1. Control options determined not to be feasible

Three available control technologies were evaluated and determined not to be feasible NOx controls for the Centralia plant. In addition, one available control option, natural gas reburning, had been evaluated for the 1997 RACT determination but was not reevaluated by TransAlta in their BART analysis. Ecology has determined that none of these control technologies are feasible controls of NOx at the Centralia plant.

ROFA/RotaMix
TransAlta did evaluate the installation of the Mobotec ROFA technology. Both Ecology and TransAlta found was that this air injection technique has been neither tested nor demonstrated in tangentially fired coal boilers of this size. Similarly, the Mobotec RotaMix technique for SNCR has not been tested or demonstrated on boilers of this size. For both Mobotec technologies, the largest tangentially fired unit reported to have the equipment is 565 MW[19,20]. This rating is below that of TransAlta's units, which are rated at 700 MW each.

Emissions information on the recent installation is not published. The technology remains untested or demonstrated on units the size of the TransAlta facility. With the current lack of information on the control efficiency on the 565 MW plant, there are questions about the capabilities of scaling the technology up to Centralia size. Under BART, facilities are not expected to assume large risk or expense for installing a new technology or technique on an untried size or type of facility[21]. As a result, Ecology concurs with TransAlta that these techniques are not yet technically feasible for use on this facility.

[19] As of 2009, The NALCO/Mobotec reports the largest tangentially fired pulverized coal unit using ROFA or Rotamix was 565MW, Minnesota Power's Boswell Unit #4. The next two largest units listed by the company are a 424 MW wall-fired unit and a 577 MW opposed fired unit achieving a 55% reduction to 0.25 lb NOx/MMBtu on bituminous coal. Telephone call with Jay Crilley, Nalco, June 24, 2009

[20] In spite of the limited application of the Mobotec ROFA technology, EPA did evaluate in its analysis of control techniques when evaluating the presumptive BART limitations. Go to the EPA's Regional Haze Rule Docket for EPA-HQ-OAR-2002-0076-0446(1) TSD.xls ,

[21] 40 CFR Part 51, Appendix Y, Section IV. D.

SCR

For new coal fired power plants, SCR is becoming the BACT control technology of choice to reduce NOx emissions. In some cases, the use of SCR is being considered to be the technology to be implemented for BART. There are a number of technical difficulties to implementing SCR at the Centralia plant presented by TransAlta in its reports. The primary difficulties are a lack of space for the catalyst beds and ducts, leading to very high construction costs that far surpass ranges of acceptable cost effectiveness. Ecology concurs with TransAlta that the construction costs to overcome the technical difficulties of retrofitting an SCR system on its boilers given its current configuration render this technology economically infeasible for implementation at this time.

Neural Nets

This technique is an available control technology. However, Ecology agrees with TransAlta that the use of this technique at the Centralia plant is not guaranteed to reduce emissions. TransAlta is likely to continue to evaluate the appropriateness of installation and sue to a neural net combustion optimization process at the facility and may at a future date choose to include it for polishing and fine-tuning operations beyond what can be achieved by their human operators.

Natural Gas Reburning

Natural gas reburning has the potential to reduce NOx emissions. Natural gas reburning is a technique where natural gas is injected into the boiler above the last overfire air ports and additional overfire air ports are added above the natural gas injection level. The natural gas has the effect of reducing part of the nitrogen oxides to nitrogen gas, carbon dioxide and water. The technique has an estimated control effectiveness of 40 -50%.

Ecology has looked briefly at the use of natural gas reburning to reduce NOx from these boilers. A review of the EPA RACT/BACT/LAER Clearinghouse database does not include any listings of this technique being used on any coal fired boiler of any size. The lack of any entries showing use of this technology for coal fired boilers of any size or type, lead us to question whether this control technique is truly available.

A 2005 review of NOx control techniques available for coal fired boilers listed 26 plants that have installed or tested reburning[22]. Of these 26 plants, only 4 were indicated as still using reburning when the review was written. The report's authors express the belief that the reason the control is not used on the plants where it is installed is simple economics; it is very costly to operate the reburn process. The 4 largest units listed in the review article, bracket TransAlta in size, but none of them were operating their reburning equipment. The few NOx emission limitations listed for reburning were higher than the control level achievable by Flex Fuels or SNCR. Based on the limited published information on installation of reburning on units the size of Centralia, we question the ability of the technology to achieve a level of control comparable to Flex Fuels or SNCR.

Natural gas reburning was not cost effective (compared to the installation of LNC3 combustion controls) in 1997. The cost of natural gas is the primary cost of using this technology. Natural

[22] See Reference 5 for details.

gas costs have increased significantly since 1997, while natural gas pipeline capacity in this part of Washington has not expanded significantly. SWCAA determined in 1997 that this control technique was not cost effective. Ecology is of the opinion that reburning is still not cost effective for implementation at the plant.

4.1.2. Evaluation of controls determined to be feasible.

LNC3/Flex Fuels
As described in Section 2, the Flex Fuels project is to allow the boilers at this plant to utilize PRB coals and accommodate its potential increased fire hazard. These modifications are relatively simple and well known in the coal combustion industry. Compared to the Centralia mine coal, PRB coal contains less nitrogen and has a higher energy content. These 2 factors work together to reduce the NOx emissions from the boilers.

The estimated capital cost to TransAlta to implement the Flex Fuels project is $101,808,663. The annualized cost of the Flex Fuel Project is $11,184,197. Based on the estimated NOx reduction of 3,139 tons/yr, the cost-effectiveness of the Flex Fuel Project is $3,563/ton of NOx reduced. Since the Flex Fuel Project also reduces SO_2 emissions by an estimated 1,287 tons/year, the cost-effectiveness of the Flex Fuel Project is $2,526/ton of NOx plus SO_2 reduced.

SNCR
SNCR has been commonly selected for BACT determinations on new and modified coal fired power plants where SCR cannot be used, as a method to meet NOx reductions required to comply with the Clean Air Interstate Rule (CAIR) program, and for seasonal NOx control requirements. SNCR has also been required to meet BART at a few facilities, although the most common BART determinations publically available from states to date is low NOx burner technology similar to that already installed at the Centralia Plant with SNCR or SCR added later as further progress emission reductions. We evaluated a 25% reduction from the use of SNCR, a level supported in the emission control literature reviewed. When this reduction is applied to the baseline emission rate of 0.304 lb NOx/MMBtu, the resulting emission limit becomes 0.23 lb NOx/MMBtu. This is marginally better than the limit of 0.24 lb NOx/MMBtu limit proposed for the Flex Fuels project.

As can be seen in Table 3-1, visibility improvement resulting from the NOx reductions from SNCR or Flex Fuels (Control Scenario 1, SNCR, and Control Scenario 2, Flex Fuels) provide essentially equal reduction in visibility impacts at all Class I areas within 300 km of the plant. In addition, the use of low sulfur sub-bituminous coals can also reduce SO_2 emissions from the plant by up to 1,300 ton/year[23]. This reduction in SO_2 emissions has not been quantified for its visibility improvement potential because the focus of the BART analysis is on NOx. BART emission limitations for SO_2 have already been established. Since sulfate and nitrate particles have essentially the same light scattering rates, we anticipate that the improvement resulting from the additional SO_2 reduction would be of the same magnitude as the visibility improvement from the similar size NOx reduction.

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[23] The effects of the SO_2 reduction was modeled and included in the January 2008 BART report. However the NOx and SO_2 rates modeled for that report are not identical to those used in the June report or the December update

As can be seen by looking at Table 3-1, the visibility improvement modeled from the NOx reduction aspects of the Flex Fuel project (Control Scenario 2) ranges from 0.45 to 0.6 dv at the 3 most heavily impacted Class I areas. This visibility improvement at the most heavily impacted Class I areas is similar to that provided by the use of SNCR (Control Scenario 1). At the least impacted Class I areas the visibility improvement due to NOx reductions by SNCR or the Flex Fuels project is identical at about 0.2 dv.

Ammonia slip from the use of an SNCR system is inevitable. TransAlta based its analyses assuming a 5 ppm slip. An SNCR system of the type contemplated for installation on these boilers normally results in an ammonia slip of 5 - 10 ppm[24]. As noted in Section 2's discussion of SNCR, there are a number of potential adverse impacts that can result from ammonia slip.

Due to the alkaline nature of the flue gas desulfurization (FGD) system at the Centralia plant, only a small amount of the ammonia entering the FGD system may be removed[25]. Ammonia can be a visibility impairing air pollutant and is a precursor to the formation of secondary $PM_{2.5}$. The presence of ammonia in the plant's exhaust will tend to increase the total quantity of ammonia available for the formation of ammonium nitrate and sulfate and ultimately in the concentration of $PM_{2.5}$ at downwind locations. This secondary $PM_{2.5}$ and ammonium aerosols increase can lead to lower visibility improvement than would be anticipated based solely on the reduction in NOx emissions.

Flex Fuels plus SNCR

Ecology has also evaluated the impacts of utilizing the Flex Fuels project and adding SNCR to further reduce NOx emissions. Assuming a 25% reduction in NOx to occur from adding SNCR to Flex Fuels, the resulting emission limit would be 0.18 lb NOx/MMBtu. The capital costs to add SNCR to Flex Fuels would increase by about 1/3 above Flex Fuels project costs to an estimated $135 million. The annual costs would increase by $6.2 million to about $17.3 million/year. The cost effectiveness of Flex Fuels plus SNCR is $2,162/ton NOx for a net reduction of 8,022 tons NOx per year. The annual cost increase is mostly to cover the cost of ammonia or urea, and to remove ammonium sulfate and bisulfate from boiler tubes and duct work between the ammonia injection point and the first ESP.

The combination of the Flex Fuels project and SNCR is cost effective. The combination of Flex Fuels and SNCR would increase the level of visibility improvement at the 3 most heavily impacted Class I areas due to NOx reductions by an additional 0.45 to 0.6 dv on the 98th

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[24] For comparison, actual monthly average SO_2 emissions from this plant are currently under 20 ppm.

[25] Ammonia can be removed from air streams with an acidic solution. It can be removed from water solutions by making the solution alkaline. The wet FGD system is alkaline.
At intermediate pHs, the ammonia partitions between ammonium and ammonia in solution according to the following formula: $f = \frac{1}{[10^{(pKa-pH)}+1]}$ Where: f = the decimal fraction of ammonia present in unionized form; pKa $= 0.09018 + \frac{2729.92}{T}$; T = water temperature in degrees Kelvin; and pH = the pH of the water solution. The unionized form is what can be emitted.

percentile day, or about double that of flex fuels or SNCR alone[26] Despite that apparent costs effectiveness, it is important to consider the incremental cost of installing SNCR given the Centralia Plant has already installed the LNC3 technology and is installing the Flex Fuels project. The capital cost to add SNCR to Flex Fuels is the same as SNCR alone since the same equipment needs to be installed. The incremental cost of adding SNCR to both units at the facility is estimated to be $2,145/ton to remove an additional 2,890 tons[27] NOx over Flex Fuels alone.

While this additional project does result in some visibility benefit, we must also weigh the other factors of the BART analysis to determine feasibility. These factors are the

- energy and non-air quality environmental impacts of compliance,
- any existing pollution control technology in use at the source, and the
- remaining useful life of the source.

There are several energy and non –air quality environmental impacts associated with SNCR. The small parasitic load associated with operating an SNCR system would reduce the power the Centralia plant has available for sale by about 1.4 MW. As previously discussed, there is also the potential for ammonia slip with SNCR, which would in turn contribute to visibility impacts. While we believe these impacts to will be manageable, they are additional operational complications resulting from the installation of SNCR.

Further, while this BART process and determination are restricted to NOx, the Flex Fuels project provides an additional reduction in SO_2, which is the more significant contributor to visibility impacts during the summer season in the Washington Class I areas nearest the Centralia Plant.

The Centralia Plant has already installed substantial emissions control technology. The LNC3 combination of combustion controls that was installed several years ago is the same technology that formed the basis for EPA's presumptive BART control technology for NOx. Throughout the western states, this package of combustion controls is being found to be BART or is a component of BART control determinations. TransAlta has informed us that they have performed boiler tuning on the installed LNC3 controls but have been unable to achieve the presumptive BART emission limitation. As documented by TransAlta, their burner package vendor has confirmed the existing LNC3 package is the latest generation of the package. While the installed LNC3 controls at the Centralia Plant do not meet the presumptive BART limitation defined by EPA, the LNC3 controls installed meet the emission reduction anticipated and required in the 1997 RACT determination. The improvement expected was about a 33% improvement from a 1996/97 average of about 0.45 lb NOx/MMBtu to the permitted 0.30 lb NOx/MMBtu.

[26] Neither Ecology nor TransAlta have performed a modeling analysis that adequately evaluates the effect of Flex Fuels plus SNCR. The closest analysis is included in the July 2008 BART Analysis Revision submitted by the company. We estimate the effects by summing the effects of each control method from the baseline emission rate of 0.30 lb/MMBtu.
[27] Based on 78% capacity factor, which is below the company target rate of over 84%

Further, the wet scrubber system installed on the plant provides in excess of 95% control of SO_2 emissions. Compared to many other plants of its vintage, the emissions of the Centralia plant are well controlled. This level of control weighs in favor of not requiring installation of significant control technology under BART given the significant NOx reductions resulting from a project already being installed.

Finally, there is the issue of the remaining useful life of the Centralia Plant. The TransAlta's investor information about its facilities states that continued operation of the Plant beyond 2030 will require a substantial capital investment[28]. However, that lifetime is longer than the BART guidance would consider as a limiting factor for making a BART technology decisions.

There are other circumstances that may result in a substantial change in the current configuration of the plant prior to that timeline. On May 21, 2009, the Governor of Washington issued Executive Order 09-05, Washington's Leadership on Climate Change. This Executive Order requires a number of specific and general actions to be accomplished. One of those specific actions is:

> (1)(d) Work with the existing coal-fired plant within Washington that burns over one million tons of coal per year, TransAlta Centralia Generation, LLC, to establish an agreed order that will apply the Greenhouse gas emissions performance standards in RCW 80.80.040(1) to the facility by no later than December 31, 2025. The agreed order shall include a schedule of major decision making and resource investment milestones;

The current greenhouse gas emission rate for the Plant is 2,300 lb total greenhouse gases/MW-hour (MWh) of electricity produced for sale. The emission performance standard in the RCW 80.80.040(1) is currently 1,100 lb total greenhouse gases/MWh of electricity produced. Meeting that performance standard would require a greenhouse gas reduction on the order of 6- 7 million tons of CO_2 per year. Also, the law (Chapter 80.80, RCW) requires an evaluation of technology every 5 years and a revision to this limitation be established by rule. The revised emission performance standard is based on the capability of new combined cycle natural gas combustion turbines offered for sale and purchase in the United States. Based on current offerings by the combined cycle combustion turbine industry, the first of the revised standards (due in 2012) is anticipated to be 850 – 920 lb/MWh.

TransAlta has a limited number of options to comply with the emission performance standard at the Centralia Plant. Those options include shutting the plant down[29], repowering it with a technology that complies with the performance standard, adding biomass to replace part of the coal supply[30], or addition of CO_2 separation and liquification equipment (along with

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[28] TransAlta Investor Day 2007, presentations published as PDF file on Nov. 17, 2007, Slide 38 of 101.
[29] Shutting down one unit would not comply with the standard.
[30] We estimate that to reduce emissions to just meet the 1100 lb/MWh standard, the plant would require biomass to replace at least 52% of the heat input to the plant. Assuming that this biomass is dry Douglas fir wood, we have estimated this to be approximately 500 dry tons/hour (over 12,000 tons/day) of biomass (probably wood or a wood derived fuel). Assumptions used in this calculation are, boiler heat input rate 8,554 MMBtu/hr/unit, dry Douglas fir wood at 8,900 Btu/dry lb, coal at 8,800 Btu/lb)

development of a viable sequestration program). Regardless of the option chosen, each would bring significant further reductions to NOx, SO_2 and PM emissions from the facility. To meet the requirements of the executive order, the likely economic lifetime of the current configuration of the Centralia Plant and any new emission control equipment would be 16 years.

4.2. Ecology's Determination of BART

Ecology is proposing BART to be the Flex Fuels project plus use of a sub-bituminous Powder River Basin coal or other coal that will achieve similar emission rates.. .

Considerations in our decision include:

- When fully installed the Flex Fuel project will provide an emissions rate of 0.24 lbs NOx/MMBTU, a 20 percent reduction from the current emissions rate. This is slightly higher than the emissions rate that would be achieved by SNCR.
- The Flex Fuels emission reductions are not exclusively NOx, but include SO_2 reductions from ability to use PRB type coals.
- The SO_2 reduction provided by the use of PRB type coals, which is allowed for by the Flex Fuels project, will provide a summertime visibility improvement during high visitor usage periods at most of the Class I areas within 300 km of the plant.
- The NOx reduction will provide mostly a fall, winter, spring visibility improvement, during lower visitor usage days and periods with cool cloudy or stormy weather.
- The Flex Fuels emission reduction project will be completed by about August 2009 with performance testing completed by the end of September 2009 allowing for compliance to occur starting with calendar October 2009.
- Additional NOx reductions from adding SNCR may not occur until 3 to 5 years from when the BART Compliance Order is issued.
- Looking at only the NOx related changes, the net visibility improvement from Flex Fuels, taking into consideration the effects of reduced sulfur emissions from using a PRB type coal, are approximately the same as Flex fuels plus SNCR.
- The Flex Fuels project does not impede any future requirement to impose SNCR (or even SCR) as part of a future reasonable progress determination.
- There will be federal requirements to reduce mercury emissions. The Flex Fuels project does not interfere with any potential mercury control technologies required by a future federal mercury control program.
- In order to meet the requirement of the Governor's Executive Order on Climate Change, TransAlta will be making significant financial and plant viability analyses of how best to comply with the Executive Order directive and the resulting Agreed Order between the company and Ecology.
- Meeting the requirements of the Executive Order will significantly affect the NOx emissions from the plant. This would occur whether compliance was achieved through shutdown of the plant, adding biofuels, or performing carbon removal and sequestration.

The emission limitation and coal quality limitation reflecting Ecology's determination of BART for NOx from the Centralia Plant is provided in Table 4-1 below. A coal meeting the nitrogen and sulfur content of the Jacobs Ranch Upper Wyodak coal depicted in Appendix A, Table A-2 is considered to be a PRB coal or equivalent coal.

If the company finds it is unable to comply with the NOx limitation in the BART order through the use of LNC3 combustion controls and Flex Fuels, it will be required to install SNCR or other NOx reduction technique that will allow the plant to meet the BART emission limitation.

Table 4-1 Ecology's Determination of the Emission Controls That Constitute BART:

BART Control Technology	Emission Limitation
Flex fuel project	0.24 lb NOx/MMBtu, 30 day rolling average, both units averaged together
Fuel Quality Requirements	Coal used shall be a sub-bituminous coal from the Powder River Basin or other coal that will achieve similar emission rates

APPENDICES

Appendix A -- Coal Quality

Table A-1
Summary of Key Centralia mine and PRB Coal Characteristics

	TransAlta Centralia Mine Coal				Powder River Basin Coal		
	Low Sulfur (<1.2%)		High Sulfur (>1.2%)				
	Mean	Max	Mean	Max	Mean	Max	From
Btu/lb	7,681	8,113	7,930	8,121	8,414	8,800	Jacobs Ranch Upper Wyodak
Sulfur (%)	0.69	0.84	1.89	2.14	0.40	0.88	Jacobs Ranch Upper Wyodak
Ash (%)	15.44	16.44	14.43	16.46	6.21	13.04	Special K Fuel
Carbon (%)	44.95	47.37	45.63	46.45	49.11	51.26	Jacobs Ranch Upper Wyodak
Nitrogen (%)	0.76	0.80	0.71	0.75	0.67	0.8	Jacobs Ranch Upper Wyodak

Coal characteristics on an "as received" basis.

Table A-2
Powder River Basin Coal Characteristics, from *BART Analysis for the Centralia Power Plant, July 2008*.

Coal Sources and Characteristics

Coal Quality Data	Units	Buckskin	Caballo 8500	Cordero Rojo	Jacobs Ranch Upper Wyodak	Rawhide	Special K Fuel	Belle Ayr	Eagle Butte
Proximate Analysis (As-Received Basis)									
Higher Heating Value	Btu/lb	8400.00	8500.00	8456.00	8800.00	8300.00	7907.00	8500.00	8400.00
Moisture	%	29.95	29.90	29.61	26.45	30.50	25.74	30.50	30.50
Volatile Matter	%	30.25	31.40	30.71	32.50	30.40	28.76	30.40	31.92
Fixed Carbon	%	34.65	33.80	34.22	34.35	34.20	32.46	34.20	32.93
Ash	%	5.15	4.90	5.46	6.70	4.90	13.04	4.90	4.65
Fixed Carbon to Volatile Matter (Fuel) Ratio		1.15	1.08	1.11	1.06	1.13	1.13	1.12	1.03
Ultimate Analysis (As-Received Basis)									
Carbon	%	49.00	49.91	49.16	51.26	48.58	45.82	50.01	49.17
Hydrogen	%	3.24	3.56	3.43	3.89	3.34	3.07	3.43	3.42
Nitrogen	%	0.63	0.71	0.71	0.80	0.63	0.56	0.67	0.67
Sulfur	%	0.35	0.36	0.32	0.88	0.37	0.28	0.26	0.38
Ash	%	5.15	4.90	5.46	6.70	4.90	13.04	4.90	4.65
Moisture	%	29.95	29.90	29.61	26.45	30.50	25.74	30.50	30.50
Chlorine	%	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01
Oxygen	%	11.68	10.66	11.31	10.01	11.68	11.49	11.12	11.20

Note: Special K Fuel is blend of Spring Creek and Kaolin coals

Appendix B

NOx Controls Evaluated in the 1997 RACT Process

		Screening Criteria used in 1997 Review						
		Technically Feasible	Increase other Emission s	Safety?	Reduce Product Marketability	Cost Competitive compared to LNB?	Mets or Exceeds CDM Emission Level	Comments
	Boiler Modifications							
1	Boiler Tuning					Yes	No	
2	Low Excess Air					Yes	No	Already Optimized
3	Burners-out-of-Service (BOOS)	Constrained by mill capacity						
4	Fuel & Air Tip Replacement					Yes	Meets	New tip developments may provide capability to meet LNB levels of NOx
5	Close Coupled Overfire Air (CCOFA)				Increased UBC potential	Yes	Meets	
6	Separated Overfire Air (SOFA)				Increased UBC potential	Yes	Meets	
7	ABB Advanced TFS-2000 System (2 levels of SOFA)	Furnace height/spacing at Centralia reduces applicability			Increased UBC potential	Yes	Meets	Limited commercial demonstration of this technology, furnace specific
8	CCOFA plus SOFA	May necessitate pressure part modifications			Increased UBC potential	Yes	Exceeds	
9	Selective Noncatalytic Reduction (SNCR)	Not demonstrated on Centralia sized unit	Ammonia slip	Ammonia	Ammonia contamination of fly ash resulting in lost sales	No	Exceeds	High reagent cost/limited reduction capability
10	SNCR plus Air heater SCR (Hybrid)	Only one partial unit coal-fired utility demonstration; no demonstrations on Centralia sized unit	Ammonia slip	Ammonia	Ammonia contamination of fly ash resulting in lost sales	No	Exceeds	High reagent & O&M cost
11	Selective Catalytic Reduction (SCR)		Ammonia slip	Ammonia	Ammonia contamination of fly ash resulting in lost sales	No	Exceeds	Extremely high capital and O&M cost
12	Natural Gas co-firing				Reduced ash sales	No	Meets	# 14 is a better variation on this option
13	Natural Gas Conversion				No ash to sell	No	Meets	Very High Fuel cost
14	Natural gas Reburn (1st Generation)	Not demonstrated on Centralia sized unit			Reduced ash sales	No	Meets	High variable cost of operation
15	Natural Gas Reburn (2nd Generation)	No Commercial Application			Reduced ash sales	No	Meets	Natural Gas Expensive

		Screening Criteria used in 1997 Review						
		Technically Feasible	Increase other Emissions	Safety?	Reduce Product Marketability	Cost Competitive compared to LNB?	Mets or Exceeds CDM Emission Level	Comments
	Combined SO_2/NOx Controls							
16	UOP/PETC Fluidized Bed Copper Oxide	Pilot level or limited use				No	Exceeds	
17	Rockwell Moving-Bed Copper Oxide Process	Pilot level or limited use				No	Exceeds	
18	NOXSO Process	Pilot level or limited use				No	Exceeds	
19	Mitsui/BF Activated Process	Pilot level or limited use				No	Exceeds	
20	Sumitomo/EPDC Activated Char Process	Pilot level or limited use				No	Exceeds	
21	Sanitech Nelsorbent SOx-NOx Control Process	Pilot level or limited use				No	Exceeds	
22	NFT Slurry with NOXOUT Process	Pilot level or limited use				No	Exceeds	
23	Ebara E-Beam Process	Pilot level or limited use				No	Exceeds	
24	Karlsruhe Electron Streaming Treatment	Pilot level or limited use				No	Exceeds	
25	ENEL Pulse-Energization Process	Pilot level or limited use				No	Exceeds	
26	California (Berkeley) Ferrous Cysteine Process	Pilot level or limited use				No	Exceeds	
27	Haldor Topsoe WSA-SOX Process	Pilot level or limited use				No	Exceeds	
28	Degussa DESONOX Process	Pilot level or limited use				No	Exceeds	
29	B&W SOx/NOx/ROx/Box (SNRB) Process	Pilot level or limited use				No	Exceeds	
30	Parsons Flue Gas Cleanup Process	Pilot level or limited use				No	Exceeds	
31	Lehigh University Low-Temperature SCR Process	Pilot level or limited use				No	Exceeds	
32	IGR/Hellpump Solid-State Electrochemical Cell	Pilot level or limited use				No	Exceeds	
33	Argonne High-Temperature Spray Drying Studies	Pilot level or limited use				No	Exceeds	
34	PETC Mixed Alkali Spray Dryer Studies	Pilot level or limited use				No	Exceeds	
35	Battelle ZnO Spray Dryer Process	Pilot level or limited use				No	Exceeds	
36	Cooper Process	Pilot level or limited use				No	Exceeds	
37	ISCA Process	Pilot level or limited use				No	Exceeds	

Controls Evaluated in Detail as part of 1997 RACT Evaluation

Emission Reduction Technology	1997 Anticipated NO_x Emission Rate (lb/MMBtu)
Boiler Tuning	0.40 to 0.44
Fuel and Air Tip Replacement	0.40 to 0.44
LNB & Close Coupled Overfire Air (CCOFA)	0.38 to 0.42
LNB & Separated Overfire Air (SOFA)	0.30 to 0.34
Selective Noncatalytic Reduction (SNCR)	0.29 to 0.33
LNB with CCOFA plus SOFA	0.26 to 0.30
Hybrid (SNCR plus air heater SCR)	0.24 to 0.28
Gas Reburning	0.20 to 0.25
Selective Catalytic Reduction (SCR)	0.10 to 0.15

Appendix C

Principal References Used

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17. Black & Veatch, **Portland General Electric Boardman Plant Best Available Retrofit Technology (BART) Analysis**, November, 2007

18. Northern States Power Co. d/b/a Xcel Energy – **Sherburne County Generating Plant Units 1 and 2 Best Available Retrofit Technology Analysis**, October, 2006

19. Pinnacle West, **Arizona Public Services, Four Corners Power Plant**, BART Analysis Conclusions, January, 2008

Appendix D

Modeling Result Information

Copied from the June 2008 BART Modeling Report, except for Table D-2 is from the January 2008 report.

Tabled D-1, D-2, and D-3 show the % contribution to visibility impairment on the days listed, the specific day and the modeled visibility on those days. The days shown are the 98th %tile for each year and the 3 years modeled. Since the same metrological information is used for each different emission scenario, the only thing that changes is the emission rate and percentage of total visibility attributable to each chemical species.

Table D-1

BART Determination Analysis Results, Extinction Budgets for Design Days
TransAlta Baseline Case

		98th Percentile Paired By Class I Area		Contribution by Species (%)					
Area of Interest	Year	Delta HI (dv)	Date	SO4	NO3	OC	EC	PMC	PMF
Alpine Lakes Wilderness	2003	3.599	5/22/2003	31.8	67.1	0.3	0.2	0.2	0.4
	2004	4.871	7/18/2004	52.9	46.2	0.3	0.1	0.1	0.3
	2005	3.856	5/4/2005	29.1	70.2	0.2	0.1	0.1	0.3
	2003-2005	4.346	9/28/2005	30.3	68.8	0.3	0.1	0.2	0.4
Glacier Peak Wilderness	2003	2.070	8/15/2003	39.1	60.0	0.3	0.2	0.1	0.4
	2004	3.615	12/24/2004	48.0	51.4	0.2	0.1	0.1	0.3
	2005	2.554	5/4/2005	37.1	62.3	0.2	0.1	0.1	0.2
	2003-2005	2.622	6/10/2003	42.5	56.8	0.2	0.1	0.1	0.3
Goat Rocks Wilderness	2003	4.207	8/7/2003	44.4	55.0	0.2	0.1	0.1	0.2
	2004	4.993	6/11/2004	42.6	55.8	0.5	0.3	0.3	0.6
	2005	3.826	12/3/2005	34.9	64.5	0.2	0.1	0.1	0.3
	2003-2005	4.286	6/25/2005	34.4	64.6	0.3	0.2	0.2	0.4
Mt. Adams Wilderness	2003	3.667	7/5/2003	33.6	65.2	0.4	0.2	0.2	0.5
	2004	3.628	7/3/2004	42.0	57.0	0.3	0.2	0.2	0.4
	2005	3.379	9/2/2005	26.7	71.5	0.5	0.3	0.4	0.6
	2003-2005	3.628	7/3/2004	42.0	57.0	0.3	0.2	0.2	0.4
Mt. Hood Wilderness	2003	2.773	10/4/2003	37.6	61.8	0.2	0.1	0.1	0.3
	2004	3.471	9/25/2004	43.9	55.2	0.3	0.1	0.1	0.4
	2005	2.159	6/29/2005	40.3	58.7	0.3	0.2	0.1	0.4
	2003-2005	2.830	9/23/2004	26.2	72.9	0.3	0.1	0.2	0.4
Mt. Jefferson Wilderness	2003	1.570	10/14/2003	37.0	62.5	0.1	0.1	0.0	0.2
	2004	2.079	8/18/2004	30.6	68.4	0.3	0.2	0.1	0.4
	2005	1.182	4/25/2005	31.5	68.0	0.2	0.1	0.1	0.2
	2003-2005	1.888	7/5/2004	32.7	66.3	0.3	0.2	0.2	0.4
Mt. Rainier National Park	2003	5.552	2/26/2003	23.6	75.9	0.2	0.1	0.1	0.2
	2004	5.447	9/21/2004	17.9	80.5	0.5	0.2	0.3	0.6
	2005	5.373	4/28/2005	26.4	72.7	0.2	0.1	0.2	0.3
	2003-2005	5.489	7/4/2005	35.0	64.1	0.3	0.1	0.2	0.4
Mt. Washington Wilderness	2003	1.374	10/14/2003	36.6	63.0	0.1	0.1	0.0	0.2
	2004	2.027	6/22/2004	43.3	56.0	0.2	0.1	0.1	0.3
	2005	0.945	8/15/2005	57.2	42.0	0.3	0.1	0.1	0.4
	2003-2005	1.414	6/23/2004	51.9	47.5	0.2	0.1	0.1	0.2
N. Cascades National Park	2003	1.557	3/30/2003	22.2	76.6	0.4	0.2	0.2	0.5
	2004	2.821	12/24/2004	47.4	52.0	0.2	0.1	0.1	0.2
	2005	1.811	5/14/2005	45.5	53.6	0.3	0.1	0.1	0.4
	2003-2005	2.212	6/5/2004	40.3	59.1	0.2	0.1	0.1	0.3
Olympic National Park	2003	3.848	12/22/2003	24.4	73.3	0.6	0.3	0.6	0.8
	2004	4.645	10/4/2004	39.3	60.2	0.2	0.1	0.1	0.2
	2005	3.629	11/20/2005	22.4	77.1	0.2	0.1	0.1	0.2
	2003-2005	4.024	3/8/2004	44.0	55.3	0.2	0.1	0.2	0.3
Pasayten Wilderness	2003	1.131	5/24/2003	48.9	50.5	0.2	0.1	0.1	0.2
	2004	1.954	12/24/2004	43.6	55.9	0.1	0.1	0.1	0.2
	2005	1.172	7/5/2005	45.0	54.1	0.3	0.1	0.1	0.4
	2003-2005	1.482	6/25/2004	56.7	42.7	0.2	0.1	0.1	0.3
Three Sisters Wilderness	2003	1.538	5/12/2003	45.7	53.9	0.1	0.1	0.1	0.2
	2004	2.172	7/27/2004	55.3	44.0	0.2	0.1	0.1	0.3
	2005	1.071	9/28/2005	53.8	45.6	0.2	0.1	0.1	0.3
	2003-2005	1.538	5/12/2003	45.7	53.9	0.1	0.1	0.1	0.2
CRGNSA	2003	2.431	9/25/2003	29.8	68.8	0.4	0.2	0.2	0.6
	2004	2.545	5/15/2004	39.2	60.1	0.2	0.1	0.1	0.3
	2005	1.714	12/13/2005	17.4	81.8	0.2	0.1	0.2	0.3
	2003-2005	2.353	1/13/2005	29.8	69.5	0.2	0.1	0.2	0.3
Overall	Min	0.945		17.4	42.0	0.1	0.1	0.0	0.2
	Mean	2.892		38.1	61.1	0.2	0.1	0.1	0.3
	Max	5.552		57.2	81.8	0.6	0.3	0.6	0.8

Table D-2 (this is from the January 2008 Report)

Table D-3

BART Determination Analysis Results, Extinction Budgets for Design Days TransAlta SNCR Case									
		98th Percentile Paired By Class I Area		Contribution by Species (%)					
Area of Interest	Year	Delta HI (dv)	Date	SO4	NO3	OC	EC	PMC	PMF
Alpine Lakes Wilderness	2003	3.094	5/22/2003	38.0	60.7	0.4	0.2	0.3	0.5
	2004	4.393	7/18/2004	60.2	38.8	0.3	0.2	0.2	0.4
	2005	3.251	5/4/2005	35.6	63.6	0.3	0.1	0.1	0.3
	2003-2005	3.844	2/27/2004	58.0	41.6	0.1	0.1	0.1	0.1
Glacier Peak Wilderness	2003	1.773	8/15/2003	46.4	52.6	0.3	0.2	0.1	0.5
	2004	3.209	4/12/2004	41.5	57.7	0.2	0.1	0.1	0.3
	2005	2.172	5/4/2005	44.4	54.9	0.2	0.1	0.1	0.3
	2003-2005	2.294	7/9/2005	43.1	55.8	0.3	0.2	0.2	0.4
Goat Rocks Wilderness	2003	3.564	8/23/2003	30.5	68.0	0.4	0.2	0.4	0.6
	2004	4.398	9/21/2004	23.4	74.8	0.5	0.3	0.4	0.7
	2005	3.314	12/3/2005	41.3	57.9	0.2	0.1	0.2	0.3
	2003-2005	3.708	6/25/2005	41.0	57.8	0.4	0.2	0.2	0.5
Mt. Adams Wilderness	2003	3.152	7/5/2003	40.1	58.4	0.4	0.2	0.3	0.6
	2004	3.188	7/3/2004	48.9	49.9	0.3	0.2	0.2	0.4
	2005	2.914	7/1/2005	31.5	66.5	0.6	0.3	0.4	0.8
	2003-2005	3.152	7/5/2003	40.1	58.4	0.4	0.2	0.3	0.6
Mt. Hood Wilderness	2003	2.388	10/4/2003	44.5	54.7	0.2	0.1	0.1	0.3
	2004	3.051	9/25/2004	51.1	47.9	0.3	0.2	0.1	0.4
	2005	1.870	6/29/2005	47.3	51.6	0.4	0.2	0.1	0.5
	2003-2005	2.388	9/5/2004	38.8	60.2	0.3	0.2	0.1	0.4
Mt. Jefferson Wilderness	2003	1.338	10/14/2003	44.0	55.5	0.2	0.1	0.0	0.2
	2004	1.784	7/29/2004	46.9	52.1	0.3	0.2	0.1	0.4
	2005	0.982	9/27/2005	37.5	61.6	0.3	0.2	0.1	0.4
	2003-2005	1.596	7/5/2004	39.2	59.6	0.4	0.2	0.2	0.5
Mt. Rainier National Park	2003	4.754	2/28/2003	48.1	50.5	0.4	0.2	0.3	0.5
	2004	4.774	7/13/2004	50.3	48.7	0.3	0.2	0.1	0.4
	2005	4.613	12/12/2005	21.8	77.4	0.2	0.1	0.2	0.3
	2003-2005	4.743	8/16/2003	64.4	33.3	0.6	0.3	0.5	0.8
Mt. Washington Wilderness	2003	1.168	10/14/2003	43.6	55.9	0.2	0.1	0.1	0.2
	2004	1.756	6/22/2004	50.6	48.5	0.3	0.1	0.1	0.4
	2005	0.845	8/15/2005	64.3	34.8	0.3	0.2	0.1	0.4
	2003-2005	1.248	6/23/2004	59.4	40.0	0.2	0.1	0.1	0.3
N. Cascades National Park	2003	1.296	6/14/2003	47.2	52.1	0.2	0.1	0.1	0.3
	2004	2.496	12/24/2004	54.5	44.9	0.2	0.1	0.1	0.3
	2005	1.583	5/14/2005	52.7	46.3	0.3	0.2	0.2	0.4
	2003-2005	1.887	4/13/2004	43.0	56.4	0.2	0.1	0.1	0.2
Olympic National Park	2003	3.328	12/19/2003	25.4	71.1	0.9	0.5	0.9	1.2
	2004	4.040	10/4/2004	46.7	52.6	0.2	0.1	0.1	0.2
	2005	3.031	6/6/2005	46.8	52.2	0.3	0.1	0.2	0.4
	2003-2005	3.456	2/26/2005	41.1	57.9	0.3	0.2	0.1	0.4
Pasayten Wilderness	2003	0.953	6/12/2003	42.1	56.9	0.3	0.2	0.1	0.4
	2004	1.701	9/24/2004	56.3	43.1	0.2	0.1	0.1	0.2
	2005	1.012	7/5/2005	52.6	46.4	0.3	0.2	0.2	0.4
	2003-2005	1.318	10/9/2005	48.5	51.1	0.1	0.1	0.1	0.2
Three Sisters Wilderness	2003	1.328	5/12/2003	53.5	46.1	0.1	0.1	0.1	0.2
	2004	1.910	6/22/2004	51.6	47.7	0.2	0.1	0.1	0.3
	2005	0.891	7/25/2005	35.0	63.9	0.4	0.2	0.2	0.5
	2003-2005	1.328	5/12/2003	53.5	46.1	0.1	0.1	0.1	0.2
CRGNSA	2003	2.049	9/25/2003	36.1	62.2	0.5	0.3	0.3	0.7
	2004	2.193	5/15/2004	46.3	52.8	0.3	0.1	0.2	0.3
	2005	1.386	12/13/2005	21.9	77.1	0.3	0.1	0.2	0.4
	2003-2005	1.942	9/5/2004	40.1	58.9	0.3	0.2	0.2	0.4
Overall	Min	0.845		21.8	33.3	0.1	0.1	0.0	0.1
	Mean	2.497		44.4	54.5	0.3	0.2	0.2	0.4
	Max	4.774		64.4	77.4	0.9	0.5	0.9	1.2

Figures D-1 – D-5 graphically depict the seasonality of visibility impacts from the TransAlta facility. 5 different Class I areas are depicted in order to indicate how the seasonality of impacts changes somewhat based on season of the year.

Figure D-1

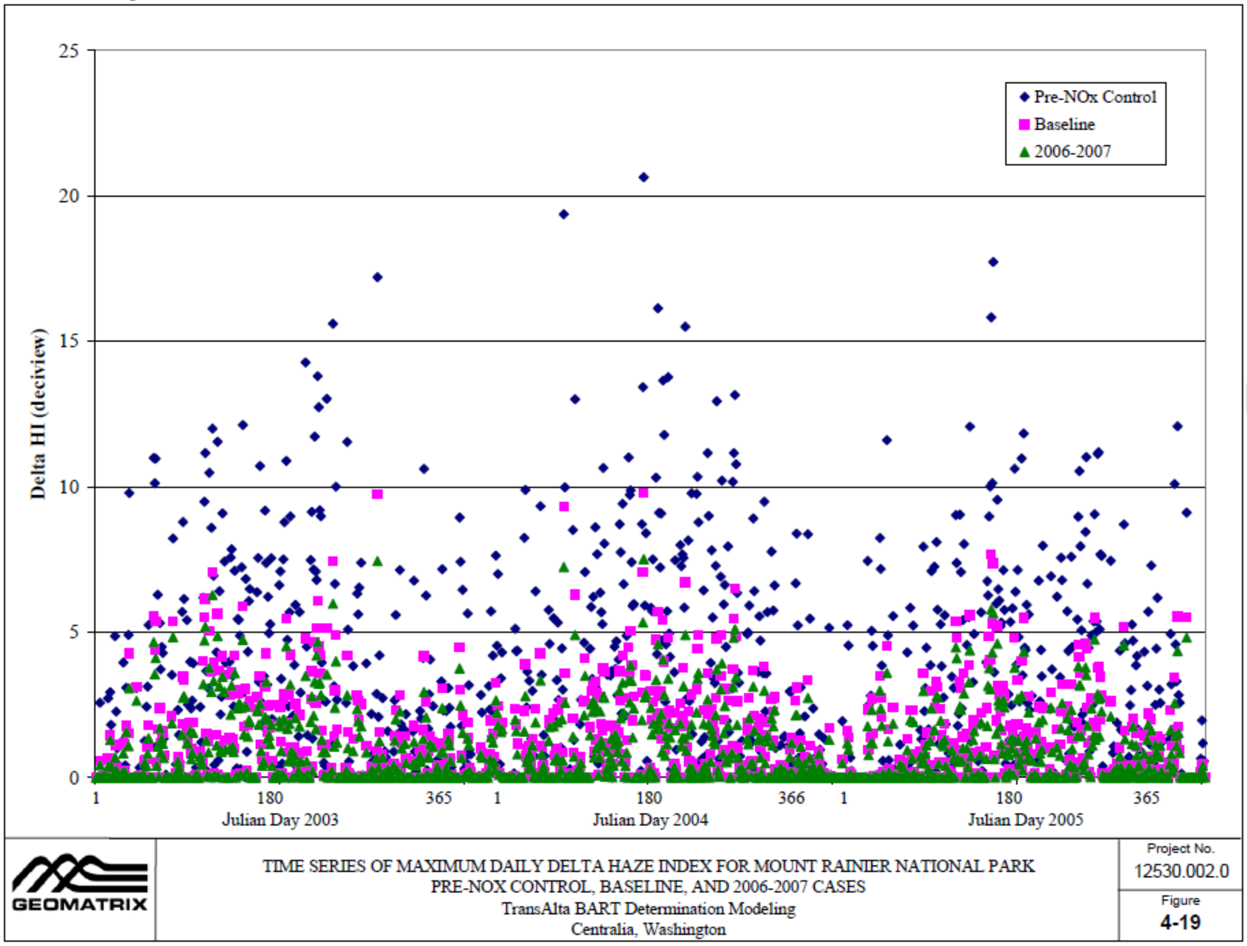
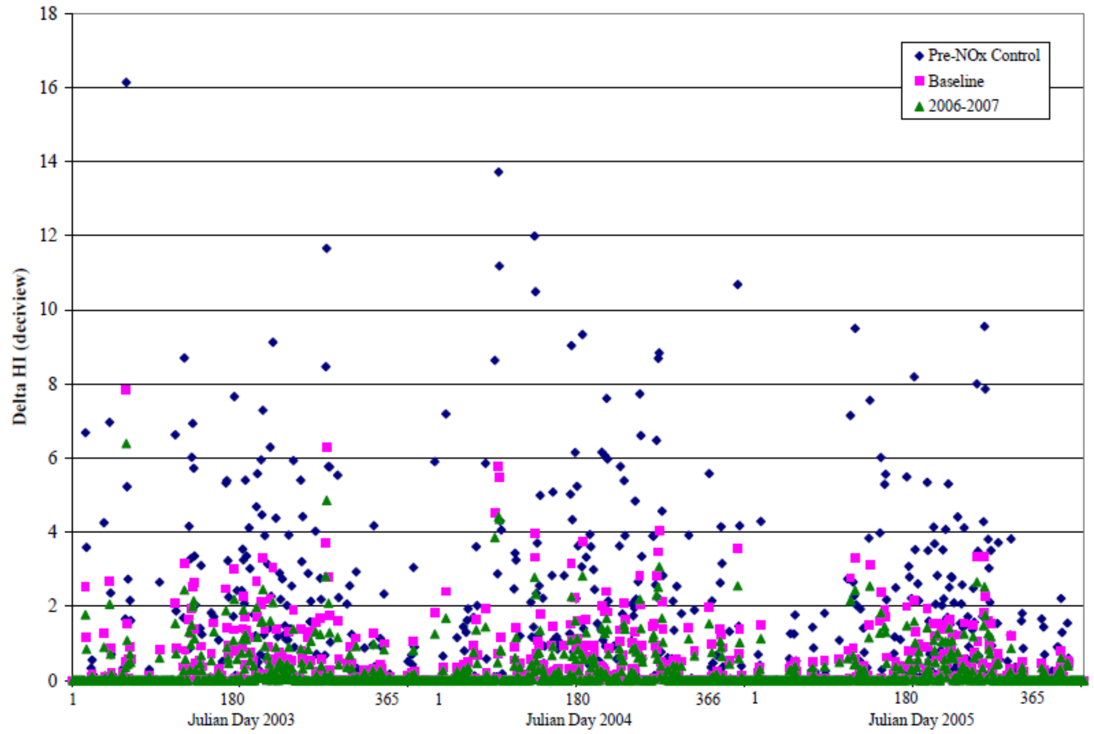


Figure D-2



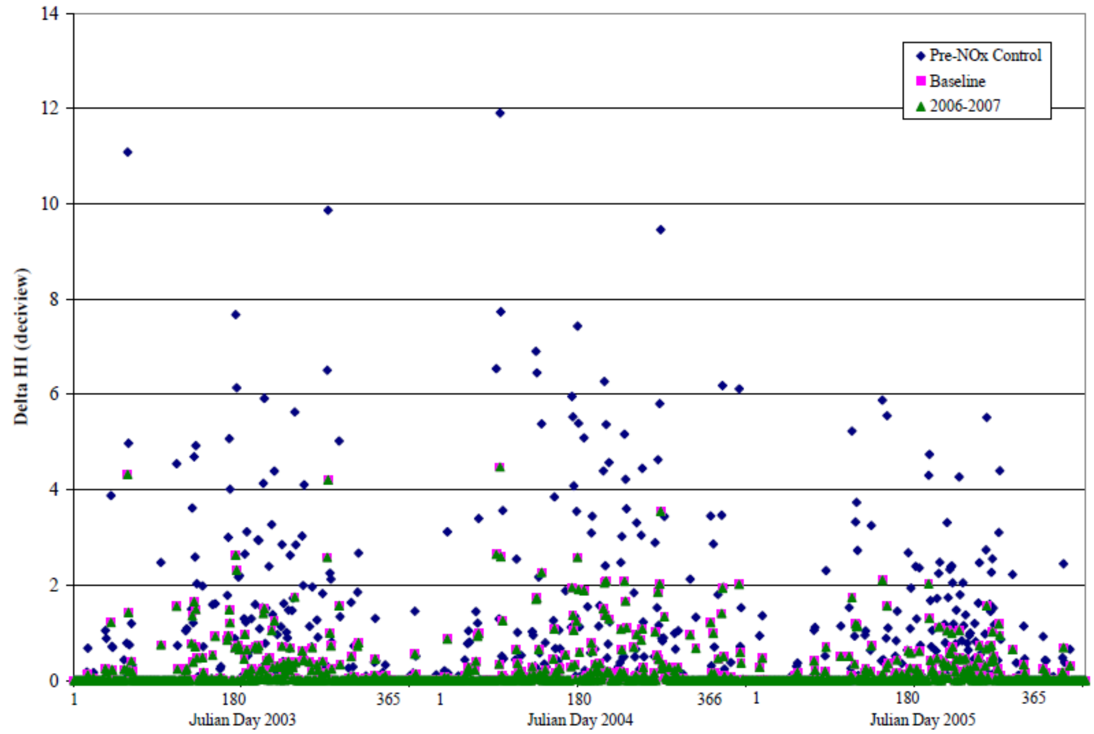
GEOMATRIX

TIME SERIES OF MAXIMUM DAILY DELTA HAZE INDEX FOR MOUNT HOOD WILDERNESS
PRE-NOX CONTROL, BASELINE, AND 2006-2007 CASES
TransAlta BART Determination Modeling
Centralia, Washington

Project No. 12530.002.0

Figure 4-13

Figure D-3



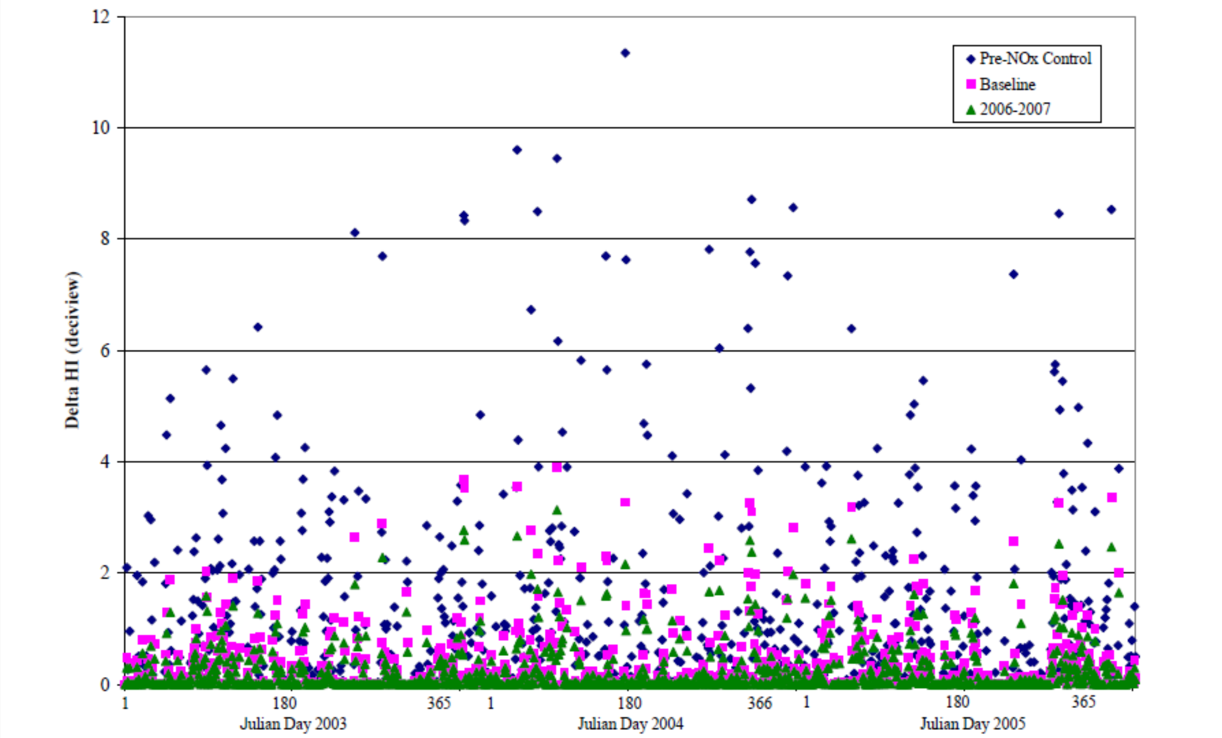
GEOMATRIX

TIME SERIES OF MAXIMUM DAILY DELTA HAZE INDEX FOR MOUNT JEFFERSON WILDERNESS
PRE-NOX CONTROL, BASELINE, AND 2006-2007 CASES
TransAlta BART Determination Modeling
Centralia, Washington

Project No. 12530.002.0

Figure 4-16

Figure D-4



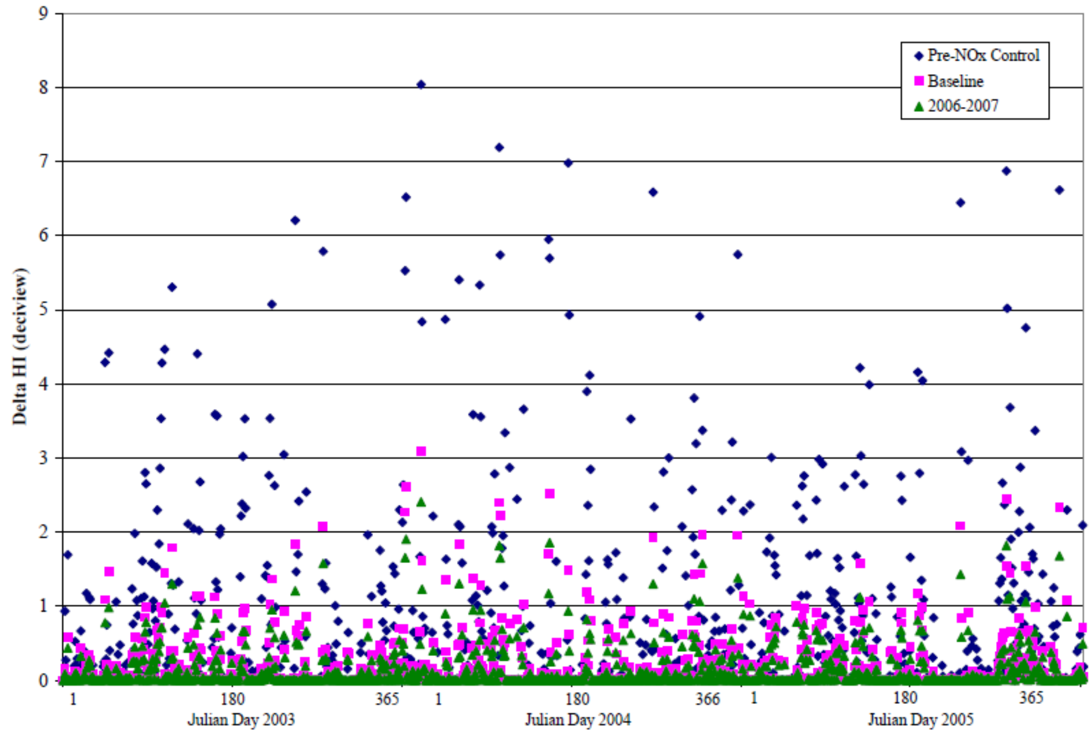
GEOMATRIX

TIME SERIES OF MAXIMUM DAILY DELTA HAZE INDEX FOR NORTH CASCADES NATIONAL PARK
PRE-NOX CONTROL, BASELINE, AND 2006-2007 CASES
TransAlta BART Determination Modeling
Centralia, Washington

Project No. 12530.002.0

Figure 4-25

Figure D-5



GEOMATRIX	TIME SERIES OF MAXIMUM DAILY DELTA HAZE INDEX FOR PASAYTEN WILDERNESS PRE-NOX CONTROL, BASELINE, AND 2006-2007 CASES TransAlta BART Determination Modeling Centralia, Washington	Project No. 12530.002.0 Figure 4-31